

# PLANT TISSUE SAMPLING IN GREENHOUSE VEGETABLES



**Shaun Casteel**  
**NCDA&CS Agronomist**

# Plant Tissue Analysis

- **Nutritional status at time of sampling**
- **Concentrations of 11 essential nutrients**
  - N, P, K
  - Ca, Mg, S
  - Fe, Mn, Zn, Cu, B
  - plus Na

# Types of Tissue Samples

- **Diagnostic**
- **Predictive**

# Diagnostic Tissue Analysis

- **Source of symptoms**
- **Pinpoint source of production problems**
  - **Nutrient deficiency**
  - **Nutrient toxicity**
  - **Other sources**
- **Determine if nutrient problems are being corrected**

# Predictive Tissue Analysis

- **Monitor nutritional status**
- **Identify & Correct**
  - nutrient shortages before symptoms develop
  - nutrient imbalances (N:S, N:K ratios)
- **Evaluate effects of fertility program on tissue concentrations and relate to growth, yield and quality**

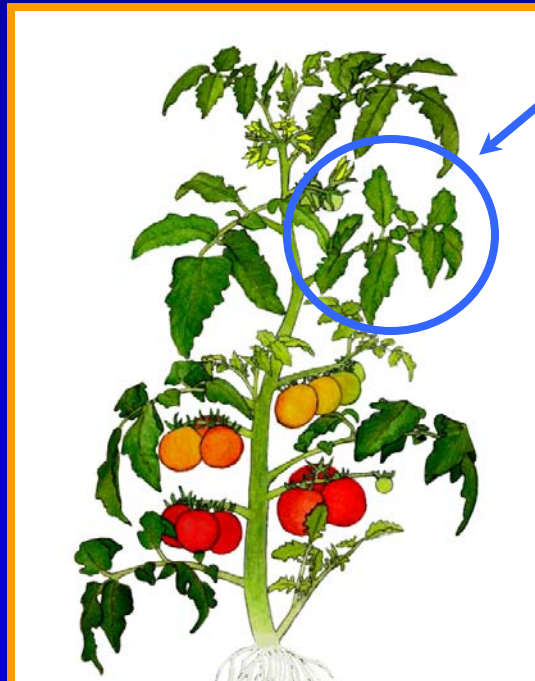
# “Proper” of Tissue Sampling

- Proper stage of growth



# “Proper” of Tissue Sampling

- Proper stage of growth
- Proper tissue - plant part, position
  - Most Recent Mature Leaf (MRML)



# **“Proper” of Tissue Sampling**

- **Proper stage of growth**
- **Proper tissue - plant part, position**
  - **Most Recent Mature Leaf (MRML)**
- **Proper sample - representative of crop**
  - **10 to 20 MRML (depending on leaf size)**





# **“Proper” of Tissue Sampling**

- **Proper stage of growth**
- **Proper tissue - plant part, position**
  - **Most Recent Mature Leaf (MRML)**
- **Proper sample - representative of crop**
  - **10 to 20 MRML**
- **Proper sample handling**
  - **paper envelopes/bags NOT PLASTIC**
  - **timely sample submission**

# **In Tissue Sampling, Avoid:**

- **Young, emerging leaves -- light green sheen**
- **Old, mature leaves -- dull green**
- **Diseased plant tissue**
- **Stressed plants**
- **Dead plant tissue**

# Plant Analysis Information Sheet

PLANT SAMPLE INFORMATION											
<b>SAMPLE TYPE</b> (circle one / see instructions) <div style="border: 1px solid black; padding: 2px; display: flex; justify-content: space-between;"> <span>Predictive (\$5)</span> <span>Diagnostic (\$5)</span> </div> <div style="border: 1px solid black; padding: 2px; display: flex; justify-content: space-between;"> <span>Research (\$12)</span> <span>Out of State (\$25)</span> </div>				<b>NCD&amp;CS Agronomic Division Plant/Waste/Solution Section</b> Mailing Address: 1040 Mail Service Center, Raleigh NC 27699-1040 Physical Address (UPS/FedEx): 4300 Reedy Creek Road, Raleigh NC 27607 Phone: (919) 733-2655 Web Address: <a href="http://www.ncagr.com/agronomi">www.ncagr.com/agronomi</a>				<b>FOR OFFICE USE ONLY</b> REPORT# _____  DATE REC'D _____ PAID _____			
GROWER INFORMATION (please print)											
<b>PAYMENT PER SAMPLE:</b> N.C. residents, \$5; Out-of-state, \$25; research, \$12; + \$2 for each extra test (Mo, O, NO <sub>3</sub> ) Make check or money order payable to NCD&CS No. Samples _____ Check ( ) Payment _____ Money Order ( ) Escrow _____ Cash ( ) Account Name _____				LAST NAME _____ FIRST NAME _____ PHONE ( ) - ____ - ____		CONSULTANT/ OTHER RECIPIENT PHONE ( ) - ____ - ____		ADDRESS _____		ADDRESS _____	
CITY _____ STATE _____ ZIP CODE _____				CITY _____ STATE _____ ZIP CODE _____		CITY _____ STATE _____ ZIP CODE _____		CITY _____ STATE _____ ZIP CODE _____		CITY _____ STATE _____ ZIP CODE _____	
SAMPLED BY _____ DATE _____				COUNTY (SAMPLES ARE FROM) _____		GROWER E-MAIL _____		FARM ID _____		OTHER RECIPIENT E-MAIL _____	

LAB NUMBER (leave blank)	SAMPLE ID	CROP NAME	GROWTH STAGE	WEEK	PLANT PART	PLANT POSITION	CORRESPONDING SAMPLE			PLANT APPEARANCE	EXTRA TESTS (\$2 EACH)		
							SOIL	SOLUTION	WASTE		Mo	Cl	NO <sub>3</sub>

GROWING CONDITIONS	PROBLEM SAMPLE COMMENTS	FERTILIZER HISTORY																									
Planting date _____ How long have symptoms been present? _____ Are plants infected with disease? Yes No Are plants infested with insects? Yes No Environmental conditions last three weeks: Rainfall: Below normal Normal Above normal Temperature: Below normal Normal Above normal Irrigation (amount) _____ Fungicides used _____	_____ _____ _____ _____ _____ _____ _____	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th>Date</th> <th>Material</th> <th>Rate</th> <th>Comments</th> </tr> </thead> <tbody> <tr> <td>Preplant:</td> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>Postplant:</td> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>Micro-nutrients:</td> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>Others:</td> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> </tbody> </table>		Date	Material	Rate	Comments	Preplant:	_____	_____	_____	_____	Postplant:	_____	_____	_____	_____	Micro-nutrients:	_____	_____	_____	_____	Others:	_____	_____	_____	_____
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# Sample Type, Grower Info.

SAMPLE TYPE (circle one / see instructions)

Predictive (\$5) Diagnostic (\$5)

Research (\$12) Out of State (\$25)

## PLANT SAMPLE INFORMATION

NCDA&CS Agronomic Division Plant/Waste/Solution Section  
Mailing Address: 1040 Mail Service Center, Raleigh NC 27699-1040  
Physical Address (UPS/FedEx): 4300 Reedy Creek Road, Raleigh NC 27607  
Phone: (919) 733-2655 Web Address: [www.ncagr.com/agronomi](http://www.ncagr.com/agronomi)

FOR OFFICE USE ONLY

REPORT#

DATE REC'D

PAID



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	ADDRESS				ADDRESS		
	CITY		STATE	ZIP CODE	CITY		STATE ZIP CODE
	COUNTY (SAMPLES ARE FROM)		GROWER E-MAIL		FARM ID		OTHER RECIPIENT E-MAIL
SAMPLED BY _____ DATE _____							

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	Lettuce,	Green	(217) 555-8888	Mr. Advisor	(217) 555 0000	
	ADDRESS			ADDRESS		
	101 Veggie Drive			Ext. or Ag. Office Road		
	CITY	STATE	ZIP CODE	CITY	STATE	ZIP CODE
	Tomato,	NC	12345	Assist,	NC	12345
SAMPLED BY <u>G. Lettuce</u> DATE <u>7/22/05</u>	COUNTY (SAMPLES ARE FROM)	GROWER E-MAIL	FARM ID	OTHER RECIPIENT E-MAIL		
	Hungry	<a href="mailto:farm@salad.com">farm@salad.com</a>	bean	<a href="mailto:advisor@help.com">advisor@help.com</a>		

# Plant Analysis Information Sheet

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<b>GROWING CONDITIONS</b> Planting date _____ How long have symptoms been present? _____ Are plants infected with disease? Yes No Are plants infested with insects? Yes No Environmental conditions last three weeks: Rainfall: Below normal Normal Above normal Temperature: Below normal Normal Above normal Irrigation (amount) _____ Fungicides used _____	<b>PROBLEM/SAMPLE COMMENTS</b> _____ _____ _____ _____ _____	<b>FERTILIZER HISTORY</b> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;"></th> <th style="width: 15%;">Date</th> <th style="width: 15%;">Material</th> <th style="width: 15%;">Rate</th> <th style="width: 45%;">Comments</th> </tr> </thead> <tbody> <tr> <td>Preplant:</td> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>Postplant:</td> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>Micro-nutrients:</td> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>Others:</td> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> </tbody> </table>		Date	Material	Rate	Comments	Preplant:	_____	_____	_____	_____	Postplant:	_____	_____	_____	_____	Micro-nutrients:	_____	_____	_____	_____	Others:	_____	_____	_____	_____
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\_\_\_\_\_

LAB NUMBER (leave blank)	SAMPLE ID	CROP NAME	GROWTH STAGE	WEEK	PLANT PART	PLANT POSITION	CORRESPONDING SAMPLE			PLANT APPEARANCE	EXTRA TESTS (\$2 EACH)			
							SOIL	SOLUTION	WASTE		Mo	Cl <sup>-</sup>	NO <sub>3</sub> <sup>-</sup>	OTHER
	Tom 1	tomato, GH	F	3	M	U		Tom 1 s		Normal				
	B ad 1	tomato, GH	F	3	M	U		Bad 1 s		Yellow leaf margins				

# Nutrient Sufficiency Ranges for

- Greenhouse (GH)

- Tomato
- Cucumber
- Lettuce
- Melons
- Pepper
- Spinach
- Strawberry
- Watercress





# Plant Analysis Information Sheet

[illegible]

# Background Information

- Growing conditions
- Additional comments
- Fertilization history

Form A-D4 (revised May 2004)

**GROWING &** **Aug 01, 2004**  
 Planting date: **Aug 01, 2004**  
 How long have symptoms been present? **1 wk**  
 Are plants infected with disease? Yes ☐ No ☒ **X**  
 Are plants infested with insects? Yes ☐ No ☒ **X**  
 Environmental conditions last three weeks:  
 Rainfall: Below normal ☐ Normal ☐ Above normal ☐  
 Temperature: Be ☐ Above normal ☐  
 Irrigation (amount) **amount**  
 Fungicide used: **Xyzr 2L**

## PROBLEM SAMPLE COMMENTS

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

## FERTILIZER HISTORY

Preplant **Tom 1 & Bad 1 = 150 N,** \_\_\_\_\_  
 Postplant **40 P, 270 K, 160 Ca,** \_\_\_\_\_  
 Micro- **40 Mg, + Micros** \_\_\_\_\_  
 nutrients \_\_\_\_\_  
 Others: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

# Submit and Pay

- **Submit complete info sheet & sample(s)**
  - **Delivery Service**
  - **Drop off**
- **Payment**
  - **\$5.00 per standard analysis**
  - **\$2.00 each for special services (molybdenum, chloride or petiole nitrates)**

# Tissue Analysis Timeline

- **Day 0**
  - Sample check-in
  - Overnight drying
- **Day 1**
  - Tissue ground and analyzed
- **Day 2**
  - Interpretation & Recommendation
  - Report mailed & posted on internet



# Plant Analysis Report

NCDA Agronomic Division 4300 Reedy Creek Road Raleigh, NC 27607-6465 (919) 733-2655

Report No. \_\_\_\_\_ **P**



## Plant Analysis Report

Grower: **Lettuce, Green** Copies To:  
**101 Veggie Drive**  
**Tomato, NC 12345**  
 Farm: **Hungry**

2/9/2004

Sample Information	Laboratory Results																	
Sample ID:	N%	P%	K%	Ca%	Mg%	S%	Fe-ppm	Mn-ppm	Zn-ppm	Cu-ppm	B-ppm	Mo-ppm	Cl%	Nc%	Ni-ppm	Co-ppm	Pb-ppm	
-----	5.11	0.54	3.76	2.49	0.63	0.55	105	31.2	27.3	10.8	32.1			0.09				
Crop:	Interpretation Indexes												Ratios			Petiole (ppm)		
GH. Tomato	N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	B	Mo	N:S	N:K	Fe:Mo	Nitrate N		
Plant Appearance:	77	53	56	68	60	61	55	51	54	55	51		9.29	1.36	3.37			
Normal	DRIS Interpretation:																	
	Most limiting--						--Least limiting											

### Recommendations:

Nutritional status of your tomato sample looks very good. Concentrations of all nutrients are within the desired ranges at this time.

**Sample ID:**

**Tom1**

**Crop**

**GH. Tomato**

**Plant Appearance**

**Normal**

# Sample Tom 1 - Results

- Normal

## Laboratory Results

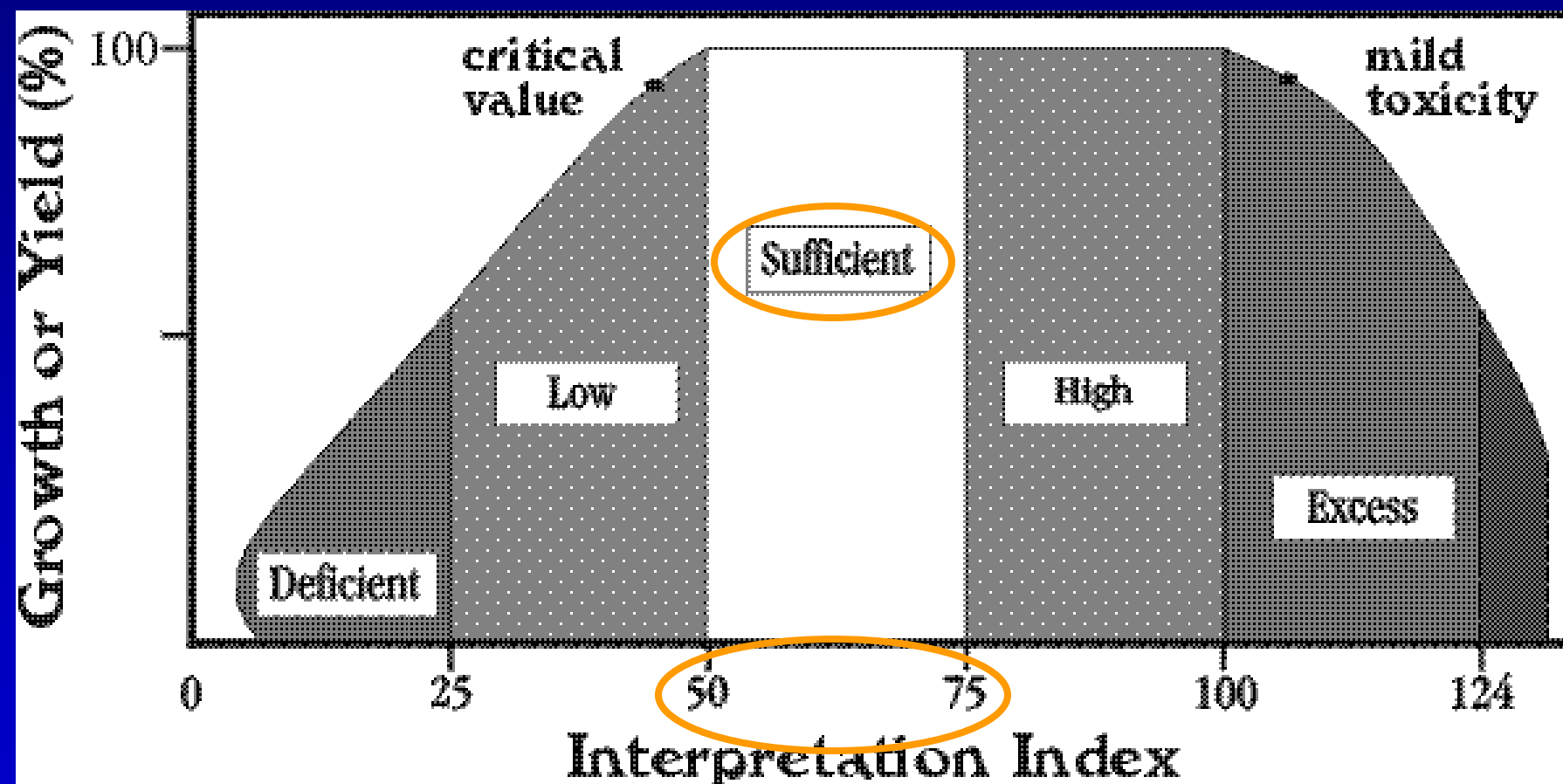
-----%-----

<i>N</i>	<i>P</i>	<i>K</i>	<i>Ca</i>	<i>Mg</i>	<i>S</i>
5.11	0.34	3.76	2.49	0.63	0.55

-----ppm-----

<i>Fe</i>	<i>Mn</i>	<i>Zn</i>	<i>Cu</i>	<i>B</i>
105	31.2	27.3	10.8	32.1

# Interpretation Index



# **GH Tomato Sufficiency Range (50 – 74)**

## **Macronutrients (%)**

<b>N</b>	<b>3.5 – 5.0</b>
<b>P</b>	<b>0.3 – 0.65</b>
<b>K</b>	<b>3.5 – 4.5</b>
<b>Ca</b>	<b>1.0 – 3.0</b>
<b>Mg</b>	<b>0.35 – 1.0</b>
<b>S</b>	<b>0.2 – 1.0</b>

## **Micronutrients (ppm)**

<b>Fe</b>	<b>50 – 300</b>
<b>Mn</b>	<b>25 – 200</b>
<b>Zn</b>	<b>18 – 80</b>
<b>Cu</b>	<b>5 – 35</b>
<b>B</b>	<b>30 – 75</b>



# Plant Analysis Report

- **Laboratory Results**
  - nutrient concentrations (% , ppm)
- **Interpretative Indices**
  - relative scale (0 to 124)
  - deficient, low, sufficient, high, excessive
- **Nutrient Ratios**
  - N:S, N:K, Fe:Mn
- **Recommendations**

# Sample Tom 1 - Results & Indices

- Normal

## Laboratory Results

-----%-----

<i>N</i>	<i>P</i>	<i>K</i>	<i>Ca</i>	<i>Mg</i>	<i>S</i>
5.11	0.34	3.76	2.49	0.63	0.55

-----ppm-----

<i>Fe</i>	<i>Mn</i>	<i>Zn</i>	<i>Cu</i>	<i>B</i>
105	31.2	27.3	10.8	32.1

## Interpretation Indices

<i>N</i>	<i>P</i>	<i>K</i>	<i>Ca</i>	<i>Mg</i>	<i>S</i>	<i>Fe</i>	<i>Mn</i>	<i>Zn</i>	<i>Cu</i>	<i>B</i>
77	53	56	68	60	61	55	51	54	55	51

**Recommendations:** Nutritional status looks very good.

# Sample Bad1 - Results & Indices

- Yellow Leaf Margins

## Laboratory Results

-----%-----					
<i>N</i>	<i>P</i>	<i>K</i>	<i>Ca</i>	<i>Mg</i>	<i>S</i>
4.54	0.36	2.90	2.59	0.56	0.66

-----ppm-----				
<i>Fe</i>	<i>Mn</i>	<i>Zn</i>	<i>Cu</i>	<i>B</i>
73.0	48.3	38.5	20.0	77.0

## Interpretation Indices

<i>N</i>	<i>P</i>	<i>K</i>	<i>Ca</i>	<i>Mg</i>	<i>S</i>	<i>Fe</i>	<i>Mn</i>	<i>Zn</i>	<i>Cu</i>	<i>B</i>
67	54	35-L	69	58	64	52	53	58	62	76

**Recommendations:** Potassium is low, which could be due to fruit load. I would make sure that you are feeding K at the recommended rate for the stage of development.

# Early Blossom End Rot

## Laboratory Results

-----%-----

<i>N</i>	<i>P</i>	<i>K</i>	<i>Ca</i>	<i>Mg</i>	<i>S</i>
4.99	0.60	4.93	1.02	0.29	0.52

-----ppm-----

<i>Fe</i>	<i>Mn</i>	<i>Zn</i>	<i>Cu</i>	<i>B</i>
89.4	93.6	26.1	16.1	34.7

## Interpretation Indices

<i>N</i>	<i>P</i>	<i>K</i>	<i>Ca</i>	<i>Mg</i>	<i>S</i>	<i>Fe</i>	<i>Mn</i>	<i>Zn</i>	<i>Cu</i>	<i>B</i>
74	71	85	50	40-L	60	54	59	53	59	53

**Recommendations:** Mg is moderately low at this time and Ca is borderline sufficient. Low concentrations of Ca influence the severity of blossom end rot. After supplying additional Ca and Mg, I suggest taking another tissue sample in 5 to 7 days. Once blossom end rot has started, it is very important to monitor Ca in the tissue.

# Solution Analysis

- 11 essential nutrients
- Sodium, chloride
- Alkalinity
  - If needed, an acid requirement
- pH, Sodium Adsorption Ratio (SAR), hardness, soluble salts
- Recommendations

# Typical Samples

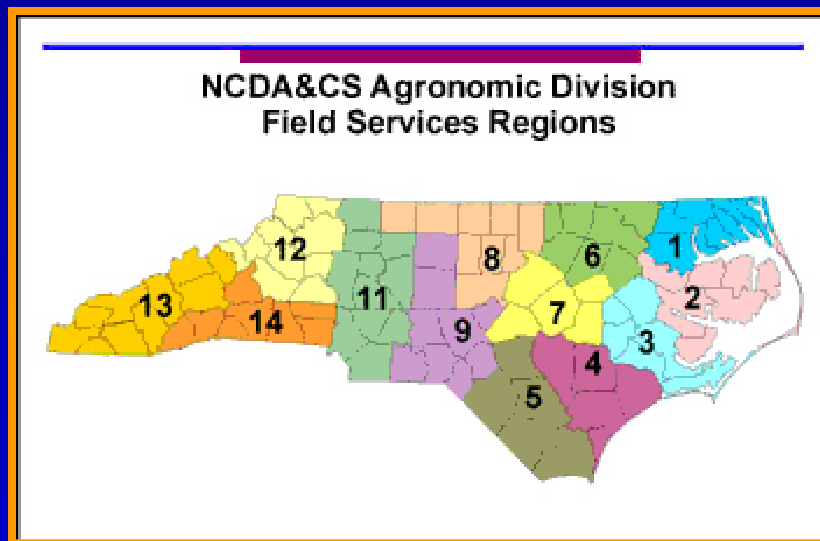
- Source water for irrigation
- Nutrient solutions
- Hydroponic solutions

# **Solution & Tissue Analyses**

- **Solution – predict nutrient availability**
- **Tissue – measure nutrient content, uptake**
- **Both play a role in GH veg. management**
- **Combination enable growers to adjust a fertility program that meets specific needs of “soil-like” or soilless media and plants.**

# Additional assistance

- On-site
  - NCDA&CS regional agronomists



- [www.ncagr.com/agronomi/](http://www.ncagr.com/agronomi/)